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Frequency-Dependent Rectification of the Bidirectionally Oscillating Dynamic Flow in Microdiffusers

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We characterize a bidirectionally oscillating dynamic flow in planar microdiffusers to investigate the frequency dependence of the flow rates and flow rectification performance of the microdiffuser. In the theoretical study, we present a bidirectionally oscillating flow model, where the boundary layer thickness governs the flow rectification performance of the microdiffusers. In the experimental study, we fabricate two types of microdiffusers, D100 and D300, having different neck widths of 100 μm and 300 μm, respectively. The net flow rates of the microdiffusers are measured for various pumping pressures and frequencies. The microdiffusers, D100 and D300, show maximum net flow rates of 116.6 μl/min and 344.4 μl/min, respectively, for an identical sinusoidal pumping pressure input of 1.6 kPa at 50 Hz. When the boundary layer thickness is greater than the neck width, the flow rates measured for D100 and D300 are approximately 47% of the theoretical values estimated using the conventional unidirectional static flow model. The experimental flow rate of D300, however, decreases at the rate of 0.18 %/Hz in the pumping frequency region higher than 90 Hz, when the boundary layer thickness is reduced to the microdiffuser neck width. Consequently, the frequency dependence of the net flow rates and the rectification performance of the planar microdiffusers are quantitatively evaluated in terms of the neck width and the boundary layer thickness developed in the bidirectionally oscillating microdiffuser flow.

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